Sustainable Aviation Fuel

Special Interest Group

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Executive Summary

The Sustainable Aviation Fuel Special Interest Group (SAF SIG) was a two-year programme (2017-2019) sponsored by Innovate UK, Sustainable Aviation and Department for Transport. The aim of the SIG was to build the UK supply chain by connecting people to relevant expertise, technology or end users. The objective was to provide a fertile environment for networking and knowledge exchange, whilst ensuring the community had the right resources on hand to support their fuel development and understand the environmental impact of their fuel.

The SAF SIG team published a series of resources: a landscape map; Cleared for offtake – a guide for producers on what airlines are looking for in a sustainable fuel; ASTM D4054 step-by-step guide to jet fuel approval, and; Research and Development priorities to support a UK sustainable aviation fuel industry. The SIG delivered a networking event attended by 130 delegates, 10 webinars, a mission to the USA plus a competition to give away an auxiliary power unit and provide two SMEs with fuel testing support.

Across the whole supply chain, the SAF SIG team supported 107 companies, built a SAF network of 406 individuals, made 82 introductions, brokered 9 collaborations and enabled four NDA’s to be signed with a UK airline.

SAF activities will continue under KTN business as usual and the team will offer sustained support for companies to access feedstock, technologies or services. A future event in 2019 or 2020 is under discussion to provide additional networking opportunities. KTN will persist in working with industry to support their objective of offering a more formal and robust jet fuel testing service in the UK, one that can keep pace with advancing SAF development around the world.
Scope

The UK’s aviation and aerospace sector contributes over £50 billion to the UK Exchequer. The connectivity of the UK via an efficient and sustainable air transport sector is vital in maintaining trade and economic growth. The UK’s own fuel resilience is of strategic importance. The UK imports 70% of aviation turbine fuel; we now have an opportunity to invest in indigenous production of sustainable alternatives to ensure fuel resilience and significant import substitution.

In 2009, the aviation industry committed to a number of climate targets, including a cap on net aviation CO$_2$ emissions (carbon-neutral growth) and a reduction in net aviation CO$_2$ emissions of 50% by 2050, relative to 2005 levels. The UN Body for aviation—the International Civil Aviation Organisation (ICAO) – identified a suite of measures to deliver a global commitment to achieve carbon neutral growth from 2020. The measures include aircraft efficiencies and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), a global market-based measure designed to offset international aviation CO$_2$ emissions. Of significance is the growing potential for sustainable fuels (see Figure 1). There is now an urgent need to meet the growing demand from airlines for SAF and develop the UK industry.

A SAF industry in the UK has the potential to deliver £265 million GVA and 4,400 jobs by 2030. In 2018, the Department for Transport included, for the first time, aviation fuel within the Renewable Transport Fuel Obligation (RTFO) in an attempt to stimulate fuel production and meet their ICAO commitment.

Figure 1. The International Civil Aviation Organisation’s (ICAO) suite of measures to deliver a global commitment to achieve carbon neutral growth from 2020. Source: https://www.icao.int/environmental-protection/Documents/CorsiaBrochure_8Panels-ENG-Web.pdf
In order to grow the UK SAF industry, R&D needs to be realised and leveraged along the whole supply chain: from feedstock providers to technology developers to engine/airframe manufacturers to airlines. Due to its broad sector knowledge, KTN is well placed to make the critical connections along the supply chain.

The SAF SIG was sponsored by Innovate UK, Sustainable Aviation and Department for Transport.

Aims and Objectives

The aim of the SAF SIG was to build the UK SAF supply chain by brokering strategic partnerships and providing the relevant tools, resources and networking opportunities.

The SAF SIG had three main objectives:

- To enable sustainable aviation fuel development in the UK to advance to commercial scale deployment through multi-disciplinary science and technology-inspired innovation and certification;
- To connect academia and industry in strategic partnerships for sustainable aviation (drop in) fuel production;
- To create multi-disciplinary approaches to deliver the development of new sustainable fuels and to ensure that the environmental and sustainability impacts of these are fully understood.
Deliverables

- We’ve attracted 130 delegates across the supply chain to a knowledge share event
- ASTM D4054 – a step-by-step guide to jet fuel approval
- We’ve awarded one auxiliary power unit to the University of Sheffield, donated by British Airways
- We’ve supported two companies to take their fuel through early stage fit for purpose testing
- We’ve supported five companies on a mission to USA
- Delivered 10 themed webinars

Cleared For Offtake
Supplying Sustainable Aviation Fuels
Prepared by:
Knowledge Transfer Network
Sustainable Aviation
Chris Lewis Fuels Consultancy

Sustainable Aviation Fuel UK Landscape
Overview

Detailed search
Five SMEs were awarded £5000 from Innovate UK through a competitive process delivered by KTN which enabled them to attend the Civil Aviation Alternative Fuel Initiative (CAAFI) in Washington DC 4-6 December 2018. The SMEs were:

- MECCOne Ltd
- Drochaid Research Services Ltd
- Susteen Technologies Ltd
- Green Fuels
- E4Tech Ltd

KTN was in attendance to support the SMEs and brokered 10 introductions for them. Between them they made 101 new connections in the US. Michelle Carter, KTN, spoke at the event on the SAF developments and innovation landscape in the UK.

A strong UK contingency was present at the meeting including DfT and the SUPERGEN Bioenergy Hub. British Airways kindly offered discounted air fares for the UK delegates.

A report submitted to Innovate UK on the Mission to the USA included a benchmarking activity and recommendations to stimulate progression for the UK industry. A copy of this report is available upon request.
Highlights and Case Studies

By request of the US Federal Aviation Administration (FAA; the regulatory and standards agency for industries including aerospace), KTN’s SAF SIG team convened a meeting with the FAA, University of Dayton, OEMs (Airbus, Boeing, Rolls Royce), independent jet fuel experts, Shell, BP and British Airways. In the US there is a support mechanism in place called the Clearing House dedicated to T1 and T2 fuel testing.

Funded by the FAA and run by the University of Dayton, the ‘Clearing House’ is a means of de-risking market entry of new jet fuel by reducing the cost of testing for fuel producers. Federal support is under threat and the FAA came to the UK to gather support towards a more global commitment to jet fuel testing.

This call to action prompted KTN to commission a study to examine the fuel testing capability in the UK and identify the best model to implement increased capacity. The completed study will inform a business case to provide dedicated support for jet fuel testing.

The SAF SIG team ran a two-strand competition in 2018:

Stream 1 – SMEs applied to receive free early-stage testing on their fuel.

Stream 2 – Universities or businesses could apply to receive an auxiliary power unit (APU) donated by British Airways.

Winners of Stream 1 were MECCOne Ltd and Renovare Fuels Ltd and were introduced initially to Chris Lewis Fuels Consultancy who developed a work plan for each SME. The University of Sheffield then conducted the early stage testing.

The University of Sheffield were successful recipients of the APU.
The SAF SIG team conducted an analysis on 49 of the companies in their SAF database to determine:

- Feedstock utilised
- Conversion technology
- Technology Readiness Level (TRL) operating at
- Carbon molecule targeted
- If their process has the potential to fit any of the approved annex in ASTM D4054
- If the feedstock they are utilising meets the criteria in Department for Transport’s Renewable Transport Fuel Obligation (RTFO)

Figure 2. Analysis of 49 companies, the carbon molecule targeted, feedstock utilised, conversion process and TRL they operate at.
Sustainable Aviation Fuel
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Analysis of 49 companies producing carbon molecules of potential value to a UK sustainable aviation fuel (SAF) industry

**Feedstock**
- 25% of companies analysed convert municipal solid waste and its fractions
- 14% companies utilise plastic waste to make fuels
- 24% of companies utilise 2nd generation biomass, whilst 35% utilise waste gases, tyres, 1st generation biomass or algae.

**Technology**
- 46% of companies use a thermochemical processing route
- 18% of companies use industrial biotechnology based routes. The remaining 36% use transesterification, chemocatalytic, electrochemical or hydrocracking processes

**Product**
- 55% of companies produce high-octane fuels like diesel or Jet A1
- 45% of companies are developing simpler, less-energy dense fuel products (e.g. syngas, hydrogen, methanol, ethanol) for non-aviation fuel markets

**Scale**
- 31% of companies operate at TRL 7-8, 31% at TRL 4-6 and 14% at TRL 1-3
- 24% of companies are operating at commercial scale
The analysis on the 49 companies is significant as it presents a picture of the potential the UK has to grow the SAF industry under current policy frameworks and inform any policy amendments. The matrix itself can be viewed as a jigsaw puzzle and KTN’s role is to connect the symbols (companies) to build the supply chain.
KPIs and Outcomes

Across the whole supply chain...

107 companies supported
406 people in the SAF SIG network
82 introductions made

9 collaborations brokered
4 companies signed NDAs with a UK airline

We've made introductions across the supply chain

21 to a service provider
6 to a feedstock provider
16 to a technology provider
11 to a refinery
4 to a fuel testing service
15 to a fuel certification expert
9 to an airline
Recommendations

- **Inter-departmental collaboration.** (e.g. DfT, BEIS, DEFRA, MOD) To deliver joint strategies.

- **Dedicated support for jet fuel testing.** To drive the industry, the UK requires a process to de-risk market entry of new fuels and subsidise fuel producers or sponsors through early stage testing. Having a recognised ‘shop front’ is essential to provide early-stage expert guidance through to early stage performance testing on an APU. KTN is currently commissioning a piece of work to conduct expertise mapping and quantify the number of new fuels which could potentially emerge for testing nationally and internationally should the UK have dedicated testing facility(ies).

- **R&D investment.** Dedicated investment to support R&D across a range of TRLs is needed as well as continued commitment to support the development of commercial production plants.

- **Regional development schemes.** Funds for local authorities to attract new businesses to the area could incentivise SAF investors and de-risk market entry. Areas with good infrastructure, including fuel pipelines to major UK airports, could be awarded grants to encourage investors whilst strengthening government’s Place agenda.

- **UK CAAFI.** An equivalent organisation to CAAFI in the UK would provide a centralised forum for strategic direction and community building. It will strengthen the growing SAF network in the UK and build on the network created by the SAF SIG.

- **Developing capacity to support DEF STAN 90-091 approval.** To ensure a secure supply of SAF to the military. By working with the MOD and DSTL, a dedicated fuel testing facility, or facilities, could offer a robust pathway to expedite uptake by the MOD and military platforms.

- **Governance.** A cross-departmental and industry SAF Working Group is required to review the science and industry challenges and implement mechanisms to advance SAF R&D to commercialisation.

- **Further networking events.** The community have requested regular events to enable them to continue networking, building new connections and being kept informed of new developments.
Next Steps

During the two-year programme, the SAF SIG team have built a vibrant self-sustaining network of companies, academics and key stakeholders. Combined with the production of resources to support the community, rather than a dedicated programme of activity, support for the SAF community will become KTN business as usual. This will include:

- Supporting companies to find technologies, services or feedstock
- Newsletter
- Notice of new grant competitions
- Developing a business case, in collaboration with fuel experts, to provide dedicated support for jet fuel testing
- Networking event 2020
- A SAF Investor Readiness Programme for SMEs

Resources and Further Reading

- Research and development priorities to support a sustainable aviation fuel industry in the UK www.safsig.co.uk
- Cleared for offtake www.safsig.co.uk
- Understanding the ASTM D4054 process for jet fuel approval www.safsig.co.uk
- Sustainable Aviation Fuel landscape map saf.ktnlandscapes.com
- Videos: youtu.be/ORMxF-T5TNk and youtu.be/Ci6paT8yLzk
- Sustainable Aviation www.sustainableaviation.co.uk
- Civil Aviation Alternative Fuel Initiative (CAAFI) www.caafi.org
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The Knowledge Transfer Network (KTN) helps businesses get the best out of creativity, ideas and the latest discoveries, to strengthen the UK economy and improve people’s lives.

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